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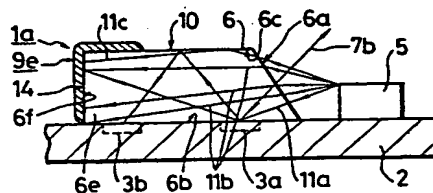
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(54) Optical pickup element.

(57) An optical pickup device having a semiconductor laser element (5) mounted on a substrate (2), a photo detector (3) formed on the substrate to receive a laser beam emitted from the semi-conductor laser element (2) and an optical element (6) mounted on the substrate to cover the photo detector to branch the direction of optical path of the laser beam. The optical element (6) is adapted to reduce the amount of unwanted stray light from the laser (5) reaching the photo detector (3). The rear face (6f) of the element (6) is coated with light absorption material (14) to substantially prevent said incident light from being reflected into the photo detector (3). The light absorption material (14) is chosen to absorb light of the wavelength(s) emitted by the laser element. The material (14) preferably has the same refractive index as the element (6).

FIG.3B



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The present invention relates generally to optical pickup devices and more particularly to an optical pickup device in which a light emitting element and a light receiving element are formed integrally on a semi-conductor substrate.

Optical heads with various structures have been proposed so far to detect information from information pits formed on the surface of a substrate, as in a compact disc (CD) or the like. Fig 1 illustrates in perspective a structure of an optical pickup device employing a composite light emitting and/or light receiving element that we have proposed in Japanese patent application number 61-38575 (published on 31st August 1987).

As fig 1 shows, there is provided an optical head 1 in which a first photo detector 3 constituted by a so-called PIN diode or the like is formed, for example, on the left-hand side half of a major surface 2A of a rectangular semi-conductor substrate 2 made of silicon or the like to act as a light receiving element. The first photo detector 3 is formed of, for example, two sets of photo detectors 3a and 3b, each of which is divided to provide three photo detecting portions. A second photo detector 4 constituted by a PIN diode or the like for monitoring is formed on the right-hand side half of the major surface 2A of the semi-conductor substrate 2 as a light receiving element, if necessary. Between the first and second photo detectors 3 and 4, a light emitting element 5 such as a semi-conductor laser chip or the like is directly soldered to the major surface 2A of the semi-conductor substrate 2. Also, there is provided an optical path branching part, ie, a prism 6. This prism 6 is trapezoidal in cross-section and is mounted on the major surface 2A of the semi-conductor substrate 2 to cover the first photo detector 3, thus forming a composite light emitting/light receiving element 1a. The prism 6 has a face 6a opposing the light emitting point of the active layer in the semi-conductor laser chip 5. This face 6a is formed as a semi-transparent reflection face. Meanwhile, in a face 6b of the prism 6 contacting with the semi-conductor substrate 2, the area other than that contacting the photo detectors 3a and 3b and a face 6c of the prism 6 opposing the face 6b are each formed as a reflection face.

With the above mentioned arrangement, a laser beam 7a emitted from the active layer of the semi-conductor laser chip 5 is reflected on the semi-transparent reflection face 6a of the prism 6 and is then irradiated on to an optical disc through an objective lens (not shown) as an incident laser beam 7b. The light of the incident laser beam 7b reflected from the optical disc travels through the face 6a of the prism 6 and is incident on the first set of photo detectors 3a. The light passed through the face 6a is reflected by a semi-transpar-

ent layer (not shown) formed between the prism 6 and the first set of photo detectors 3a and is then reflected on the face 6c of the prism 6 to become incident on the second set of photo detectors 3b, whereby the data corresponding to the information pits on the optical disc are detected. A laser beam 7c is emitted from an opposite active layer of the semi-conductor laser chip 5 for monitoring.

In the above mentioned composite light emitting/light receiving element 1a, a part of the laser beam, which is emitted from the semi-conductor laser chip 5, travels through the prism 6 and directly becomes incident on the first photo detector 3 and this undesired, stray light constitutes noise added to the detecting signal.

From experimental results, it was noted that while the undesired light incident on the prism 6 can be removed in the conventional composite light emitting/light receiving element 1a, another kind of undesired light is produced which exerts a bad influence upon the detecting signal that the first photo detector 3 produces.

Referring to fig 2, let us now explain why such other kind of undesired light is produced. Fig. 2 is a fragmentary cross-sectional side view taken through the line II-II of Fig. 1, looking in the direction indicated by the arrow A. Except for the semi-transparent reflection face 6a of the prism 6 formed on the major surface 2A of the semi-conductor substrate 2 to cover the first photo detector 3, left, right and rear, side wall faces 6d, 6e and 6f are formed as faces that are not calendered. For example, they are formed as smoked-glass faces. For this reason, a part of the laser beam 7a emitted from the active layer of the semi-conductor laser chip 5 travels through the semi-transparent reflection face 6a and is then reflected and/or scattered on the side wall faces 6d, 6e and 6f in the prism 6. Thus, as shown by reflected and/or scattered laser beams 8 represented as broken lines in Fig. 2, undesired light again becomes incident on the light receiving faces of the photo detectors 3a and 3b with a smaller incident angle $\theta 1$. Such an undesired light is superimposed upon an RF signal from the first photo detector 3 as a DC offset signal, thereby to exert a bad influence on the detecting signal. Another reason that there exists much undesired light beams which are repeatedly reflected and/or scattered within the prism 6 is that the refractive index of the material forming the prism 6 is larger than the refractive index of air and hence the undesired light beams are not radiated from the prism 6 to the air.

EP-A-0199565 discloses an optical pickup device comprising:

- (a) a substrate;
- (b) a semi-conductor laser element mounted on said substrate;

(c) a photo detector for receiving a laser beam emitted from said semi-conductor laser element formed on said substrate; and
 (d) an optical path branching optical element fixed to said substrate over said photo detector, said optical element including an inclined front face positioned opposite said laser element and having a semi-transparent reflection film deposited thereon and a rear face positioned opposite said front face. This optical pickup device is susceptible to the abovementioned problem of stray laser light from the laser element becoming incident on the photo detector to cause electrical noise.

It is an aim of the present invention and/or the preferred embodiments to provide an improved optical pickup device which can produce a stable detecting signal from a photo detector thereof and be manufactured at low cost.

According to the present invention, there is provided an optical pickup device comprising:

- (a) a substrate;
- (b) a semi-conductor laser element mounted on said substrate;
- (c) a photo detector for receiving a laser beam emitted from said semi-conductor laser element mounted on said substrate; and
- (d) an optical path branching optical element fixed to said substrate over said photo detector, said optical element including an inclined front face positioned opposite said laser element and having a semi-transparent reflection film deposited thereon and a rear face positioned opposite said front face;

characterised in that said rear face is coated with light absorption material to substantially absorb light incident thereon to substantially prevent said incident light from being reflected into said photo detector, said light absorption material being chosen to absorb light of the wavelength(s) emitted from said semi-conductor laser element.

An embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of an example of optical pickup device not in accordance with the present invention;

Fig. 2 is a cross-sectional side view taken through the line II-II in Fig. 1, looking in the direction represented by arrow A;

Fig 3A is a plan view illustrating an embodiment of optical pickup device according to the present invention; and

Fig. 3B is a fragmentary cross-sectional side view of the device of Fig. 3A.

Fig 3A illustrates in plan view an embodiment of optical pickup device in accordance with the present invention and employing a composite light

emitting/light receiving element.

In Figs. 3A and 3B, like parts corresponding to those of Figs. 1 and 2 are marked with the same references and therefore need not be described in detail.

In Figs. 3A and 3B, the shape of the rear side wall face 6f of the prism 6 is not modified at all as compared with that shown in Figs. 1 and 2 but a light absorption material 14 is coated on the left and right side wall faces 6d and 6e and the rear side wall face 6f of the prism 6. The kind of light absorption material 14 is selected in accordance with the wavelength of the laser beam emitted from the semi-conductor laser chip 5. For example, a black paint or the like is coated on the left and right side wall faces 6d and 6e and the rear side wall face 6f with a predetermined coating pattern. Since an area 10 of the upper face 6c of the prism 6 is necessary for reflecting the signal detecting light which results from reflecting the laser beam 7b on the optical disc so as to become incident on the photo detector element 3b, the light absorption material 14 is not coated on the area 10 of the upper face 6c of the prism 6 which reflects such light beam as mentioned above. The light absorption material 14 may be coated on the rear area of the upper face 6c of the prism 6 as illustrated in Fig. 3A.

Further, the light absorption material 14 may be of a material that has the same refractive index as that of the prism 6. If the kind of the light absorption material 14 is selected as described above, the reflection on the interface between the prism 6 and the light absorption material 14 can be removed.

According to the above mentioned arrangement, almost all of the incident laser beams propagating along the optical paths 11a to 11c within the prism 6, which will become the undesired light beams, can be absorbed by the light absorption material 14, thus forming the undesired light preventing means 9e.

By coating light absorption material on the rear face of the prism of the illustrated embodiment of the invention, undesired light within the prism can be substantially avoided, removing the need to separate electronically the detecting signal and undesired light. Thus, without such a separation circuit, the optical pickup can substantially avoid the problem of undesired light and produce a stable detecting signal from its photo detecting means. Also, the optical pickup device of the present invention can be manufactured at low cost.

Claims

1. An optical pickup device comprising:
 - (a) a substrate (2);

(b) a semi-conductor laser element (5) mounted on said substrate (2);
(c) a photo detector (3) for receiving a laser beam emitted from said semi-conductor laser element (5) mounted on said substrate (2); and

(d) an optical path branching optical element (6) fixed to said substrate (2) over said photo detector (3), said optical element (6) including an inclined front face (6a) positioned opposite said laser element (5) and having a semi-transparent reflection film deposited thereon and a rear face (6f) positioned opposite said front face;

characterised in that said rear face (6f) is coated with light absorption material (14) to substantially absorb light incident thereon to substantially prevent said incident light from being reflected into said photo detector (3), said light absorption material (14) being chosen to absorb light of the wavelength(s) emitted from said semi-conductor laser element.

2. A device as claimed in claim 1, wherein the optical path branching optical element (6) has left and right side faces (6d, 6e), said side faces also being coated with light absorption material (14). 25
3. A device as claimed in claim 1 or claim 2, wherein the optical path branching optical element (6) has an upper surface (6c), a portion of said upper surface adjacent to said rear face (6f) being coated with light absorption material (14). 30 35
4. A device as claimed in any of the preceding claims, wherein the light absorption material (14) is applied to the optical path branching optical element (6) in a predetermined coating pattern. 40
5. A device as claimed in any of the preceding claims, wherein the light absorption material (14) is black paint or the like. 45
6. A device as claimed in any of the preceding claims, wherein said light absorption material (14) has the same refractive index as the optical path branching optical element (6). 50

FIG. 1

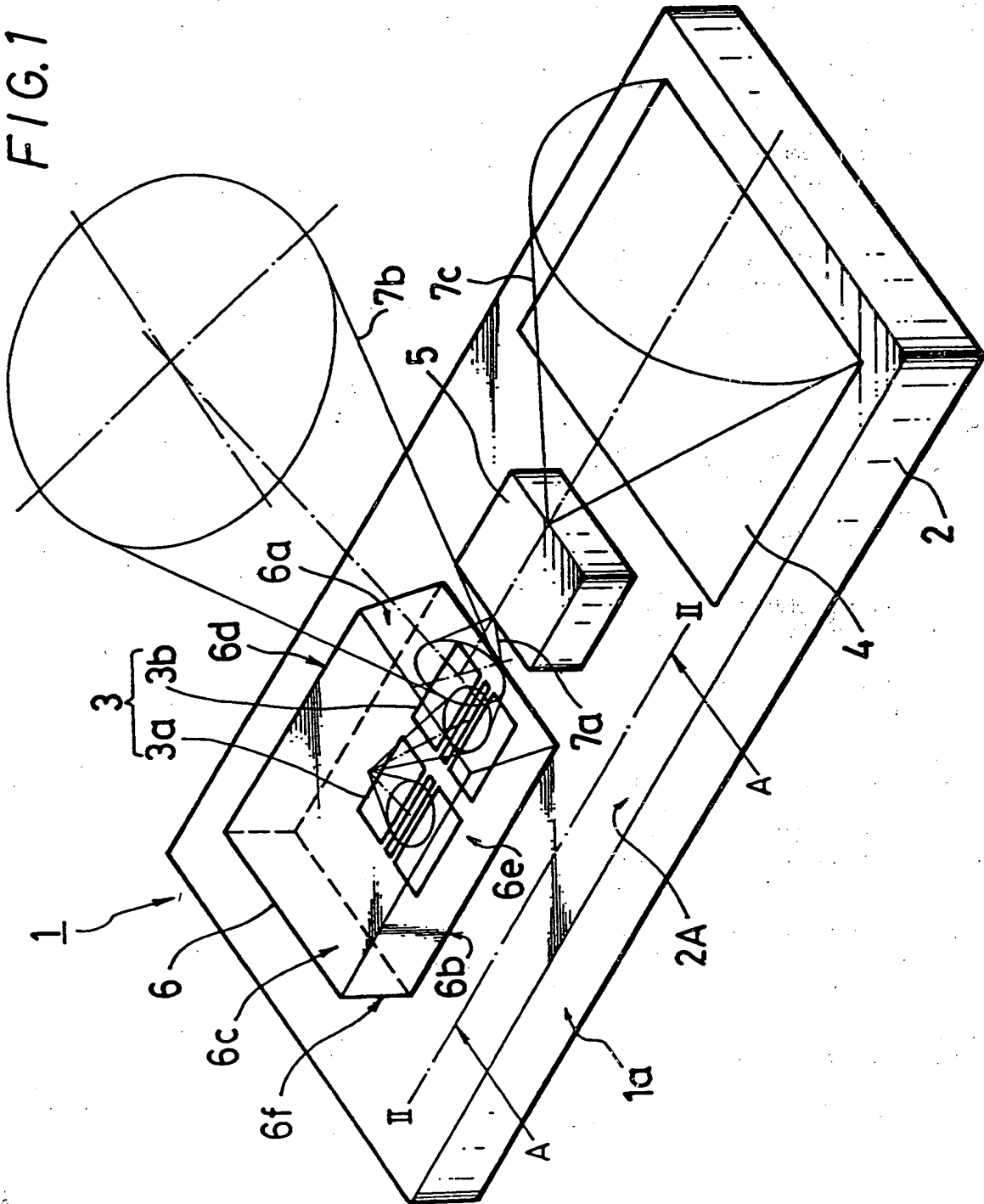


FIG. 2

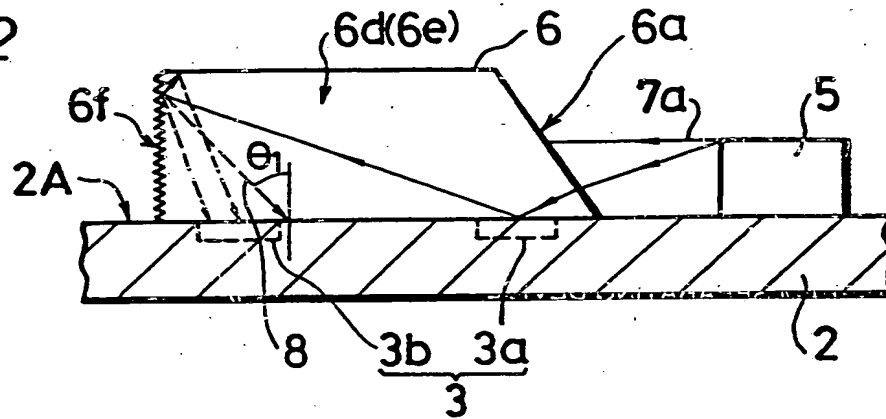


FIG. 3A

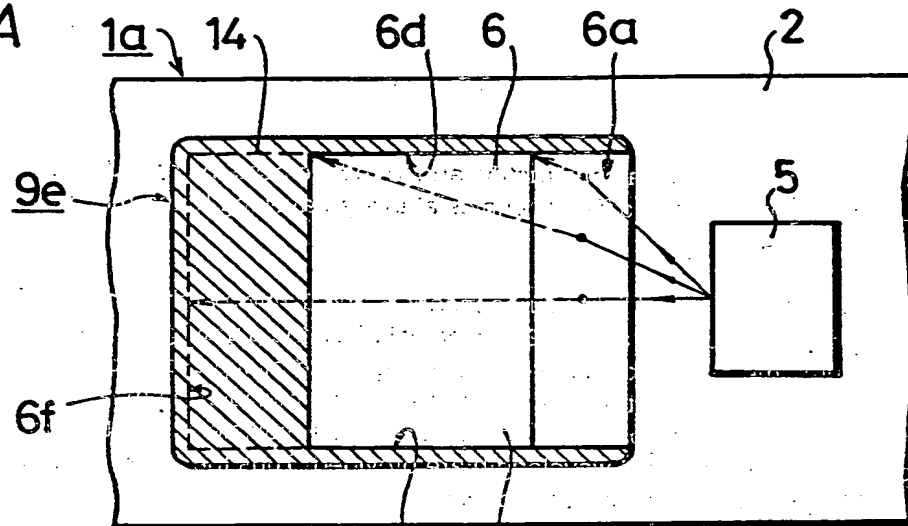


FIG. 3B

